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(54) Title: NOVEL BICYCLIC CANNABINOID AGONISTS FOR THE CANNABINOID RECEPTOR

(57) Abstract: Novel polycyclic cannabinoid analogs are presented which have preferentially high affinities for the cannabinoid CB2 receptor sites. The improved receptor affinity makes these analogs therapeutically useful as medications in individuals and animals for treatment of pain, glaucoma, epilepsy, nausea associated with chemotherapy.

NOVEL BICYCLIC CANNABINOID AGONISTS FOR THE CANNABINOID RECEPTOR

Field of the Invention

The present invention relates generally to cannabinoid compounds and is more particularly concerned with new and improved cannabinoid compounds exhibiting high binding affinity and selectivity for the CB1 and CB2 cannabinoid receptors, pharmaceutical preparations employing these analogs and methods of administering therapeutically effective amounts of the preparations to provide a physiological effect.

Background of the Invention

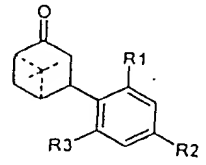
Classical cannabinoids such as the marijuana derived cannabinoid Δ^9-tetrahydrocannabinol, (Δ^9-THC) produce their pharmacological effects through interaction with specific cannabinoid receptors in the body. So far, two cannabinoid receptors have been characterized: CB1, a central receptor found in the mammalian brain and peripheral tissues and CB2, a peripheral receptor found only in the peripheral tissues. Compounds that are agonists or antagonists for one or both of these receptors have been shown to provide a variety of pharmacological effects. See, for example, Pertwee, R.G., Pharmacology of cannabinoid CB1 and CB2 receptors, Pharmacol. Ther., (1997) 74:129 - 180 and Di Marzo, V., Melck, D., Bisogno, T., DePetrocellis, L., Endocannabinoids: endogenous cannabinoid receptor ligands with neuromodulatory action, Trends Neurosci. (1998) 21:521 - 528.

There is considerable interest in developing cannabinoid analogs possessing high affinity for one of the CB1 or CB2 receptors. Such analogs may offer a rational therapeutic approach to a variety of disease states.

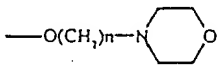
Summary of the Invention

The inventive compounds have been found to act as agonists for the CB1 and CB2 receptors. The invention includes compounds selective for either the CB1 or CB2 receptors. Certain of the novel bicyclic cannabinoids possess

surprisingly improved cannabinoid receptor affinity and/or specificity over known cannabinoids. Thus, one aspect of the invention is the novel cannabinoids represented by structural formula 1 and physiologically acceptable salts thereof.

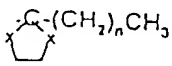


structural formula 1

wherein R_1 is selected from the group consisting of OH; H; OCH_3; N_3; NH_2; $O(CH_2)_nN(CH_3)_2$ and 

;where n is an integer from 1 - 3;

R_2 is selected from the group consisting of $(CH_2)_nCH_3$, where n is an integer from 4 - 6; $C(CH_3)_2(CH_2)_nCH_3$, where n is an integer from 3 - 5;



where X is selected from the group consisting of C, O, S and NH and n is an integer from 3 - 5; $(CH_2)_nC{\equiv}C$ where n is an integer from 3 - 5; $C{\equiv}C(CH_2)_nCH_3$ where n is an integer from 2 - 4 and

where R is $(CH_2)_nCH_3$, where n is a maximum of 7;and

R_3 is selected from the group consisting of H; OH; OCH_3; N_3 and $O(CH_2)_nOH$; where n is an integer from 1 - 5.

The novel cannabinoids are also more polar (less lipophilic) then known cannabinoids, which can improve their therapeutic usefulness in certain applications. Therefore, the novel compounds described herein, and physiologically acceptable salts thereof, represent potentially useful materials for providing a physiological effect to treat pain; peripheral pain; glaucoma; epilepsy; nausea such as associated with cancer chemotherapy; AIDS Wasting Syndrome; cancer; neurodegenerative diseases including Multiple Sclerosis, Parkinson's Disease, Huntington's Chorea and Alzheimer's Disease; to enhance appetite; to

reduce fertility; to prevent or reduce diseases associated with motor function such as Tourette's syndrome; to prevent or reduce inflammation; to provide neuroprotection and to suppress memory and produce peripheral vasodilation. Thus, another aspect of the invention is the administration of a therapeutically effective amount of an inventive compound, or a physiologically acceptable salt thereof, to an individual or animal to provide a physiological effect.

Description of Some Preferred Embodiments

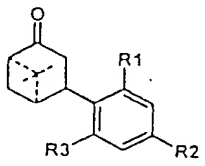
As used herein a "therapeutically effective amount" of a compound, is the quantity of a compound which, when administered to an individual or animal, results in a sufficiently high level of that compound in the individual or animal to cause a discernible increase or decrease in stimulation of cannabinoid receptors. Physiological effects that result from cannabinoid receptor stimulation include analgesia, decreased nausea resulting from chemotherapy, sedation and increased appetite. Other physiological functions include relieving intraocular pressure in glaucoma patients and suppression of the immune system. Typically, a "therapeutically effective amount" of the compound ranges from about 10 mg/day to about 1,000 mg/day.

As used herein, an "individual" refers to a human. An "animal" refers to, for example, veterinary animals, such as dogs, cats, horses and the like, and farm animals, such as cows, pigs and the like.

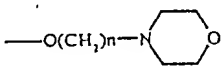
The compound of the present invention can be administered by a variety of known methods, including orally, rectally, or by parenteral routes (e.g., intramuscular, intravenous, subcutaneous, nasal or topical). The form in which the compounds are administered will be determined by the route of administration. Such forms include, but are not limited to, capsular and tablet formulations (for oral and rectal administration), liquid formulations (for oral, intravenous, intramuscular or subcutaneous administration) and slow releasing microcarriers (for rectal, intramuscular or intravenous administration). The formulations can also contain a physiologically acceptable vehicle and optional adjuvants, flavorings, colorants and preservatives. Suitable physiologically to

acceptable vehicles may include, for example, saline, sterile water, Ringer's solution, and isotonic sodium chloride solutions. The specific dosage level of active ingredient will depend upon a number of factors, including, for example, biological activity of the particular preparation, age, body weight, sex and general health of the individual being treated.

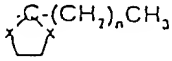
The novel cannabinoids can generally be described with reference to structural formula 1 and include physiologically acceptable salts thereof.



structural formula 1

wherein R_1 is selected from the group consisting of OH; H; OCH_3; N_3; NH_2; $O(CH_2)_nN(CH_3)_2$ and  ;where n is an integer from 1 - 3;

R_2 is selected from the group consisting of $(CH_2)_nCH_3$, where n is an integer from 4 - 6; $C(CH_3)_2(CH_2)_nCH_3$, where n is an integer from 3 - 5;

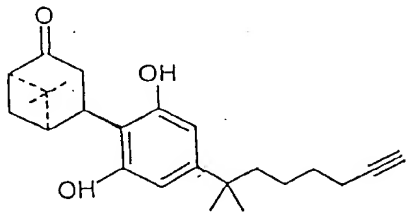
 where X is selected from the group consisting of C, O, S and NH and n is an integer from 3 - 5; $(CH_2)_nC{\equiv}C$ where n is an integer from 3 - 5; $C{\equiv}C(CH_2)_nCH_3$ where n is an integer from 2 - 4 and

 where R is $(CH_2)_nCH_3$, where n is a maximum of 7;and

R_3 is selected from the group consisting of H; OH; OCH_3; N_3 and $O(CH_2)_nOH$; where n is an integer from 1 - 5.

The following examples are given for purposes of illustration only in order that the present invention may be more fully understood. These examples are not intended to limit in any way the practice of the invention. Material AM1703

was prepared. Material AM1703 can be represented by structural formula 1 when R_1 and R_3 are each OH and R_2 is 1,1-dimethylheptyl. Material AM1703 is shown in structural formula 2.



structural formula 2

Material AM1703 was prepared as follows.

[7-(3,5-Dimethoxyphenyl-1,3-dithian-7-yl)-1-heptynyl]trimethysilane.

A solution of 5 g (19.5 mmol) of 2-(3,5-dimethoxyphenyl)-1,3-dithiane in 38 mL of dry tetrahydrofuran was cooled to –30 °C under argon and 14.5 mL of a 1.6 M solution (23.5 mmol) of n-butyllithium in hexanes was added dropwise. The yellow-brown reaction mixture was stirred at the same temperature for 2 hours (h) and 5.43 g (23.4 mmol, neat) of (6-bromo-1-hexynyl)trimethysilane was added in a dropwise manner when the color changed from yellow-brown to light yellow. The reaction mixture was allowed to warm to room temperature overnight and poured into water and extracted with diethyl ether. The combined organic extracts were dried and ether removed to afford the crude product which was purified on silica gel (15% diethyl ether-petroleum ether) to afford 6.81 g (86%) of the title compound as an oil. Anal. calcd. for $C_{21}H_{32}O_2S_2Si$ C, 61.72; H, 7.89.

[7-(3,5-Dimethoxyphenyl)-7-oxo-1-heptynyl]trimethylsilane.

A solution of 6.40 g (15.8 mmol) of [7-(3,5-dimethoxyphenyl-1,3-dithian-7-yl)-1-heptynyl]trimethysilane in 160 mL of 10% aqueous methanol was cooled in an ice-bath and 10.2 g (23.7 mmol, 1.5 equiv.) of bis(trifluoroacetoxy)iodobenzene was added portionwise with stirring. The reaction mixture was stirred for an additional 10 min and poured into 100 mL of sodium bicarbonate solution. The mixture was extracted with diethyl ether, ether extracts were combined, dried

and ether removed to afford an oil which was chromatographed on silica gel to afford 4.5 g (90%) of the title compound. Anal. calcd. for $C_{18}H_{26}O_3Si$ C, 67.88; H, 8.23.

[7-(3,5-Dimethoxyphenyl)-7-methyl-1-octynyl]trimethysilane. [7-(3,5-Dimetho-xyphenyl)-7-oxo-1-heptynyl]trimethysilane (1.50 g, 4.75 mmol) was dissolved in 10 mL of anhydrous ether, the solution was cooled in an ice-bath under argon and a 3.16 mL of a 3 M solution of methylmagnesium bromide (9.48 mmol) in ether was added dropwise. The light grey solution was allowed to warm to room temperature and stirred for an additional hour. The reaction mixture was poured into saturated ammonium chloride solution, the organic phase was separated and the aqueous phase was extracted with fresh diethyl ether. The combined ether extracts were dried and ether removed to afford 1.50 g (95%) of pure [7-(3,5-dimethoxyphenyl)-7-hydroxy-1-octynyl]trimethysilane as a viscous oil after passing through a short silica gel column.

The above tertiary carbinol (1.50 g, 4.52 mmol) was dissolved in 9 mL of anhydrous carbon tetrachloride and dry hydrogen chloride gas was bubbled through for 1 h. The solution was transferred to a separatory funnel with the aid of more carbon tetrachloride, washed with water and 10% sodium bicarbonate solution. The organic phase was dried and rotary evaporated to afford an oil which was passed through a short silica column to give 1.43 g (90%) of the pure [7-chloro-7-(3,5-dimethoxyphenyl)-1-octynyl]trimethysilane.

A solution of the above chloride (1.43 g, 4.08 mmol) in dry toluene was cooled to −30 °C under argon and 4.1 mL of a 2 M solution of trimethylaluminum in toluene was added in a slow dropwise manner. The resulting clear reaction mixture was stirred at room temperature for about 16 hours and then 5% aqueous hydrochloric acid was added in a very cautious manner. The organic layer was separated, washer with water, dried and toluene removed. The residual oil was chromatographed on silica gel to afford a colorless oil. Anal. calcd. for $C_{20}H_{32}O_2Si$ C, 72.23; H, 9.70.

7-(3,5-Dimethoxyphenyl)-7-methyl-1-octyne (8-065).

[7-(3,5-Dimethoxyphenyl)-7-methyl-1-octynyl]trimethysilane (900 mg, 2.73 mmol) was dissolved in 3.5 mL of anhydrous methanol. Anhydrous potassium carbonate (75 mg, 0.55 mmol, 20 mol %) was added and the heterogeneous mixture was stirred at room temperature, under argon, for 24 h. The reaction mixture was diluted with water and extracted with diethyl ether. The ether extract was dried, concentrated by rotary evaporation and the residue was purified by chromatography on silica gel (5% ethyl ether-petroleum ether) to give 540 mg (76%) of the desilylated product. Anal. calcd. for $C_{17}H_{24}O_2$ C, 78.42; H, 9.29.

3-(1,1-Dimethylhept-6-ynyl)resorcinol (8-065).

A solution of 7-(3,5-dimethoxyphenyl)-7-methyl-1-octyne (445 mg, 1.71 mmol) in 17 mL of anhydrous dichloromethane was cooled to –40 °C under argon and 4.3 mL of a 1M solution of boron tribromide (4.30 mmol) was added via syringe. The reaction mixture was allowed to warm to 0 °C with stirring over a period of 1 - 1.5 h and then quenched with saturated sodium bicarbonate. The organic layer was separated, dried and solvent removed. The residue was chromatographed on silica gel (30-40% ethyl ether-petroleum ether) to give 224 mg (56%) of the title resorcinol. Anal. calcd. for $C_{15}H_{20}O_2$ C, 77.55; H, 8.68.

Coupling of 3-(1,1-dimethylhept-6-ynyl)resorcinol with nopinone diacetate. A mixture of 224 mg (0.97 mmol) of 3-(1,1-dimethylhept-6-ynyl)resorcinol, 270 mg (0.97 mmol) nopinone diacetate and 185 mg (0.97 mmol) of *p*-toluenesulfonic acid monohydrate in 10 mL of chloroform was allowed to stand at room temperature for 4 h as described by Archer et al. After confirming the completion of the reaction by TLC, the reaction mixture was transferred to a separatory funnel and washed successively with 10% sodium bicarbonate, water, and dried. Solvent was removed and the residue was purified by flash chromatography on silica gel (30-40% ethyl ether- petroleum ether) to give 140 mg (40%) of the title bicyclic ketone (AM1703).

As used herein, "binding affinity" (K_i) is represented by the IC_{50} value which is the concentration of an analog required to occupy the 50% of the total number (Bmax) of the receptors. The lower the IC_{50} value the higher the binding affinity. As used herein an analog is said to have "binding selectivity" if it has higher binding affinity for one receptor compared to the other receptor; e.g. a cannabinoid analog which has an IC_{50} of 0.1 nanomoles (nM) for CB1 and 10 nM for CB2, is 100 times more selective for the CB1 receptor. The AM1703 material was tested for CB2 receptor binding affinity and for CB1 receptor affinity (to determine selectivity for the CB2 receptor).

For the CB1 receptor binding studies, membranes were prepared from rat forebrain membranes according to the procedure of P.R. Dodd et al, A Rapid Method for Preparing Synaptosomes: Comparison with Alternative Procedures, Brain Res., 107 - 118 (1981). The binding of the novel analogues to the CB1 cannabinoid receptor was assessed as described in W.A. Devane et al, Determination and Characterization of a Cannabinoid Receptor in a Rat Brain, Mol. Pharmacol., 34, 605 - 613 (1988) and A. Charalambous et al, 5'-azido Δ^8-THC: A Novel Photoaffinity Label for the Cannabinoid Receptor, J. Med. Chem., 35, 3076 - 3079 (1992) with the following changes. The above articles are incorporated by reference herein.

Membranes, previously frozen at -80 °C, were thawed on ice. To the stirred suspension was added three volumes of TME (25mM Tris-HCl buffer, 5 mM $MgCl_2$ and 1 mM EDTA) at a pH 7.4. The suspension was incubated at 4 °C for 30 min. At the end of the incubation, the membranes were pelleted and washed three times with TME.

The treated membranes were subsequently used in the binding assay described below. Approximately 30 µg of membranes were incubated in silanized 96-well microtiter plate with TME containing 0.1% essentially fatty acid-free bovine serum albumin (BSA), 0.8 nM [^{3}H] CP-55,940, and various concentrations of test materials at 30 °C for 1 hour. The samples were filtered using Packard Filtermate 196 and Whatman GF/C filterplates and washed with wash buffer (TME containing 0.5% BSA). Radioactivity was detected using

MicroScint 20 scintillation cocktail added directly to the dried filterplates, and the filterplates were counted using a Packard Instruments Top-Count. Nonspecific binding was assessed using 100 nM CP-55,940. Data collected from three independent experiments performed with duplicate determinations was normalized between 100% and 0% specific binding for [^{3}H] CP-55,940, determined using buffer and 100 nM CP-55,940. The normalized data was analyzed using a 4-parameter nonlinear logistic equation to yield IC_{50} values. Data from at least two independent experiments performed in duplicate was used to calculate IC_{50} values which were converted to K_i values using the using the assumptions of Cheng et al, Relationship Between the Inhibition Constant (K_i) and the concentration of Inhibitor which causes 50% Inhibition (IC_{50}) of an Enzymatic Reaction, Biochem. Pharmacol., 22, 3099-3102, (1973), which is incorporated by reference herein.

For the CB2 receptor binding studies, membranes were prepared from frozen mouse spleen essentially according to the procedure of P.R. Dodd et al, A Rapid Method for Preparing Synaptosomes: Comparison with Alternative Procedures, Brain Res., 226, 107 - 118 (1981) which is incorporated by reference herein. Silanized centrifuge tubes were used throughout to minimize receptor loss due to adsorption. The CB2 binding assay was conducted in the same manner as for the CB1 binding assay.

Binding affinities (K_i) for both the CB1 and CB2 receptors are typically expressed in nanomoles (nM), although novel compound AM1703 surprisingly exhibited a CB2 affinity of 0.59 picomoles (pM) and about a 500-fold CB2 selectivity over CB1. Other cannabinoid analogs have been reported that show some selectivity for the CB2 receptor. However the inventive analog described herein has surprisingly high affinity and selectivity for the CB2 receptor.

The physiological and therapeutic advantages of the inventive materials can be seen with additional reference to the following references, the disclosures of which are hereby incorporated by reference. Arnone M., Maruani J., Chaperon P, *et al*, Selective inhibition of sucrose and ethanol intake by SR141716, an antagonist of central cannabinoid (CB1) receptors,

Psychopharmacal, (1997) 132, 104-106. Colombo G, Agabio R, Diaz G. et al: Appetite suppression and weight loss after the cannabinoid antagonist SR141716. Life Sci. (1998) 63-PL13-PL117. Simiand J, Keane M, Keane PE, Soubrie P: SR 141716, A CB1 cannabinoid receptor antagonist, selectively reduces sweet food intake in marmoset. Behav. Pharmacol (1998) 9:179-181. Brotchie JM: Adjuncts to dopamine replacement a pragmatic approach to reducing the problem of dyskinesia in Parkinson's disease. Mov. Disord. (1998) 13:871-876. Terranova J-P, Storme J-J Lafon N et al: Improvement of memory in rodents by the selective CB1 cannabinoid receptor antagonist, SR 141716. Psycho-pharmacol (1996) 126:165-172. Hampson AL Grimaldi M. Axpirod J. Wink D: Cannabidiol and (-) Δ^9 tetrahydrocannabinol are neuroprotective antioxidants. Proc. Natl Acad Sci. USA (1998) 9S:8268-8273. Buckley NE, McCoy KI, Mpzey E et al Immunomodulation by cannabinoids is absent in mice deficient for the cannabinoid CB_2 receptor. Eur. J Pharmacol (2000) 396:141-149. Morgan Dr: Therapeutic Uses of Cannabis. Harwood Academic Publishers, Amsterdam. (1997). Joy JE, Wagtson SJ, Benson JA: Marijuana and Medicine Assessing the Science Base. National Academy Press, Washington, DC, USA (1999). Shen M. Thayer SA: Cannabinoid receptor agonists protect cultured rat hippocampal neurons from excitotoxicity. Mol. Pharmacol (1996) 54:459-462. DePetrocellis L, Melck D, Palmisano A. et al: The endogenous cannabinoid anandamide inhibits human breaast cancer cell proliferation. Proc Natl. Acad. Sci USA (1998) 95:8375-8380. Green K. Marijuana smoking vs. cannabinoids for glaucoma therapy: Arch. Ophibalmol. (1998) feb 433-1437. Hemming M, Yellowlees PM, Effective treatment of Tourette's syndrome with marijuana. J. Psychopharmacol, (1993) 7:389-391. Muller-Vahl KB, Schneider U, Kolbe H, Emrich, HM. Treatment of Tourette's syndrome with delta-9-tetrahydrocannabinol. Am. J. Psychiat. (1999) 156-195. Muller-Vahl KB, Kolbe H, Schneider U, Emrich, HM Cannabis in movement disorders. Porsch. Kompicmentarmed (1999) 6 (suppl. 3) 23-27. Consroe P, Musty R, Rein J, Tillery W, Pertwee R. The perceived effects of smoked cannabis on patents with multiple sclerosis, Eur. Neurol. (1997) 38-44-48. Pinnegan-Ling D, Musty R.

Marinol and phantom limb pain: a case study. Proc Inv. Cannabinoid Rea. Sec. (1994):53. Brenneisen R, Pgli A, Elsohly MA, Henn V. Spiess Y: The effect of orally and rectally administered Δ^9 - tetrahydrocannabinol on spasticity, a pilot study with 2 patients. Int. J. Clin Pharmacol Ther. (1996) 34:446-452. Martyn CN. Illis LS, Thom J. Nabilone in the treatment of multiple sclerosis. Lancet (1995) 345:579. Maurer M, Henn V, Dittrich A, Hofmann A. Delta-9-tetrahydrocannabinol shows antispastic and analgesic effects in a single case double-blind trial. Eur. Arch. Psychiat. Clin. Neurosci. (1990), Z40:1-4. Herzberg U, Eliav E, Bennett GJ, Kopin IJ: The analgesic effects of R(+) WIN 55,212-2 mesylate, a high affinity cannabinoid agonist in a rare model of neuropathic pain. Neurosci. Letts. (1997) 221:157-160. Richardson JD, Kilo S. Hargreaves KM, Cannabinoids reduce dryperalgesia and inflammation via interaction with peripheral CB1 receptors. Pain (1998) 75:111-119. Ricardson JD, Aanonsen I, Hargreaves KM: Antihyperalgesic effects of a spinal cannabinoids. Eur. J. Pharmacol. (1998) 346:145-153. Calignano A, La Rana G. Diuffrida A, Piomelli D: Control of pain initiation by endogenous cannabinoids. Nature (1998) 394:277-291. Wagner JA, Varga K, Jarai Z, Kunos G: Mesenteric vasodilation mediated by endothelia anandamide receptors. Hypertension (1999) 33:429-434. Schuel, H., Burkman, L.J., Picone, R.P., Bo, T., Makriyannis, A., Cannabinoid receptors in human sperm. Mol. Biol. Cell., (1997) (8), 325a.

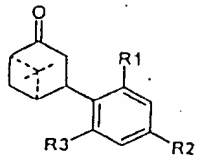
The inventive analogs described herein, and physiologically acceptable salts thereof, have high potential when administered in therapeutically effective amounts for providing a physiological effect useful to treat pain; peripheral pain; glaucoma; epilepsy; nausea such as associated with cancer chemotherapy; AIDS Wasting Syndrome; cancer; neurodegenerative diseases including Multiple Sclerosis, Parkinson's Disease, Huntington's Chorea and Alzheimer's Disease; to enhance appetite; to reduce fertility; to prevent or reduce diseases associated with motor function such as Tourette's syndrome; to prevent or reduce inflammation; to provide neuroprotection and to suppress memory and produce peripheral vasodilation. Thus, another aspect of the invention is the administration of a therapeutically effective amount of an inventive compound,

or a physiologically acceptable salt thereof, to an individual or animal to provide a physiological effect.

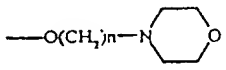
Those skilled in the art will recognize, or be able to ascertain with no more than routine experimentation, many equivalents to the specific embodiments of the invention disclosed herein. Such equivalents are intended to be encompassed by the scope of the invention.

What Is Claimed Is:

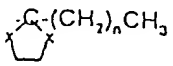
1. A compound of the formula :



structural formula 1

wherein R_1 is selected from the group consisting of OH; H; OCH_3; N_3; NH_2; $O(CH_2)_nN(CH_3)_2$ and  ;where n is an integer from 1 - 3;

R_2 is selected from the group consisting of $(CH_2)_nCH_3$, where n is an integer from 4 - 6; $C(CH_3)_2(CH_2)_nCH_3$, where n is an integer from 3 - 5;

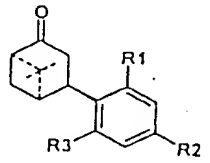
 where X is selected from the group consisting of C, O, S and NH and n is an integer from 3 - 5; $(CH_2)_nC{\equiv}C$ where n is an integer from 3 - 5; $C{\equiv}C(CH_2)_nCH_3$ where n is an integer from 2 - 4 and

 where R is $(CH_2)_nCH_3$, where n is a maximum of 7;and

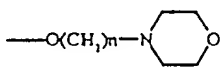
R_3 is selected from the group consisting of H; OH; OCH_3; N_3 and $O(CH_2)_nOH$; where n is an integer from 1 - 5.

2. The compound of claim 1 wherein R_1 and R_3 are each OH and $R_2$is 1,1-dimethylheptyl.

3. A method of preferentially stimulating the CB2 receptors in an individual or animal comprising administering to the individual or animal a therapeutically effective amount of a compound having the formula:

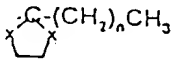


structural formula 1

wherein R_1 is selected from the group consisting of OH; H; OCH_3; N_3; NH_2; $O(CH_2)_nN(CH_3)_2$ and 

;where n is an integer from 1 - 3;

R_2 is selected from the group consisting of $(CH_2)_nCH_3$, where n is an integer from 4 - 6; $C(CH_3)_2(CH_2)_nCH_3$, where n is an integer from 3 - 5;



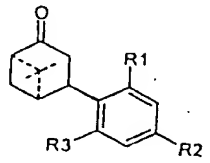
where X is selected from the group consisting of C, O, S and NH and n is an integer from 3 - 5; $(CH_2)_nC{\equiv}C$ where n is an integer from 3 - 5; $C{\equiv}C(CH_2)_nCH_3$ where n is an integer from 2 - 4 and

where R is $(CH_2)_nCH_3$, where n is a maximum of 7;and

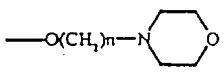
R_3 is selected from the group consisting of H; OH; OCH_3; N_3 and $O(CH_2)_nOH$; where n is an integer from 1 - 5.

4. The method of claim 3 wherein R_1 and R_3 are each OH and R_2 is 1,1-dimethylheptyl.

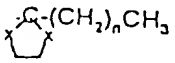
5. A pharmaceutical composition containing a therapeutically effective amount of a compound having the formula :



structural formula 1

wherein R_1 is selected from the group consisting of OH; H; OCH_3; N_3; NH_2; $O(CH_2)_nN(CH_3)_2$ and  ;where n is an integer from 1 - 3;

R_2 is selected from the group consisting of $(CH_2)_nCH_3$, where n is an integer from 4 - 6; $C(CH_3)_2(CH_2)_nCH_3$, where n is an integer from 3 - 5;

 where X is selected from the group consisting of C, O, S and NH and n is an integer from 3 - 5; $(CH_2)_nC{\equiv}C$ where n is an integer from 3 - 5; $C{\equiv}C(CH_2)_nCH_3$ where n is an integer from 2 - 4 and

 where R is $(CH_2)_nCH_3$, where n is a maximum of 7;and

R_3 is selected from the group consisting of H; OH; OCH_3; N_3 and $O(CH_2)_nOH$; where n is an integer from 1 - 5.

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(54) Title: NOVEL BICYCLIC CANNABINOID AGONISTS FOR THE CANNABINOID RECEPTOR

(57) Abstract: Novel polycyclic cannabinoid analogs are presented which have preferentially high affinities for the cannabinoid CB2 receptor sites. The improved receptor affinity makes these analogs therapeutically useful as medications in individuals and animals for treatment of pain, glaucoma, epilepsy, nausea associated with chemotherapy.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/41238

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : C07C 39/12; A01N 43/16
US CL : 568/719, 514/453
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 568/719, 514/453

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST, CAplus, Registry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DRAKE et al. Classical/Nonclassical Hybrid Cannabinoids. J. Med. Chem. 1998, Vol. 41, No. 19, pages 3596-3608, see entire document.	1, 2, 3, 4, 5
Y	HUFFMAN et al. Synthesis of 5', 11-Dihydroxy- 8-tetrahydrocannabinol. Tetrahedron. 1997, Vol. 53, No. 39, pages 13295-13306, see entire document.	1, 2, 3, 4, 5
X	US 4,102,902 A (ARCHER et al.) 25 July 1978, see entire document.	1, 2
Y	ARCHER et al. Cannabinoids. Synthethic Approaches to 9-Ketocannabinoids. Total synthesis of nabilone. J. Org. Chem. 1977, Vol. 42, No. 13, pages 2277-2284, see entire document.	1, 2, 3, 4

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents
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22 FEBRUARY 2001	18 APR 2001
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International application No.
PCT/US00/41238

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUFFMAN et al. Synthesis of both enantiomers of nabilone from a common intermediate. Enantiodivergen Synthesis of Cannabinoids. J. Org. Chem., 1991, Vol. 56, No. 6, pages 2081-2086, see entire document.	1, 2, 3, 4, 5
X	US 4,208,351 A (ARCHER et al.) 17 June 1980, see entire document.	1, 2, 3, 4, 5
Y	US 4,876,276 A (MECHOULAM et al.) 24 October 1989, see entire document.	1, 2, 3, 4, 5
X	US 4,176,233 A (ARCHER et al) 27 November 1979, see entire document	1, 2, 3, 4, 5
Y - X	US 5,605,906 A (LAU et al.) 25 February 1997, see entire document.	1, 2, 4, 5 ---------- 3
A	US 5,948,777 A (BENDER et al) 07 September 1999, see entire document.	1, 2, 3, 4, 5